Space Weather Technical Forecast

Issued on Thursday, 12 September 2024 at 13:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Ongoing CME influence, with further arrival forecast late day 2 or early day 3 (11-12 Sep). G1-G2 Minor to Moderate storms expected day 1 and likely day 3 (11 and 13 Sep). Moderate to High solar activity.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: High with peak flare X1.3 from a new region on the southeast limb, yet to be visible on Earth-facing disc. There are ten sunspot regions, including this one, with six of these forming a cluster of sunspots in the southwest disc. The most notable is AR3811, on the west limb, which was the source of an M5.0 flare at 12/0022 UTC. AR3814, just west of north-centre disc is also of note, with a weak delta spot ahead of its main large symmetrical trailer spot. The other main spots on the disc are AR3822, just east of AR3814 and AR3824 in the southeast, however these have shown signs of simplifying and remain relatively inactive.

There were no Earth-directed CMEs observed in this period.

Solar Wind / Geomagnetic Activity: Two CMEs were observed arriving at L1, the first from the 08 Sep CME at 11/1425 UTC and the second has been preliminarily assessed as being an early arrival of the 10 Sep CME at 12/0253 UTC, perhaps also arriving in two separate shock and material components. Solar wind speed from ACE at L1 rose from around 350 km/s to just 370km/s with the first arrival, then rose again to 420km/s at 12/0253, then again at 12/0820 UTC to be around 500-550km/s at times. Density rose above average with the arrival of the first CME, and then varied between average and above average levels with the second arrival. The Interplanetary Magnetic Field (IMF), Bt, was initially Weak, but increased to Moderate with the arrival of the first CME, peaking at 12nT at 11/1730 UTC. This rose further with the second CME, becoming Moderate to Strong, in the range 12-27nT, with peak 12/0935 UTC. The north-south component remained unremarkable with the first arrival, but became mainly negative (southward) from 12/0340 UTC with brief positive (northward) spells, with periods of Moderate to Strong southward field. This ranged +16 to -24nT with minimum at 12/1135UTC. The phi angle was variable at times, but mainly positive (away from the Sun). Geomagnetic activity was Quiet to Unsettled with the first arrival, but became Active to G2 Moderate Storm from 12/0600-1200 (Kp 4-6).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 was very near background, and continued to decline to background. High energy electron flux (greater than 2MeV) observed by GOES16 was at background to moderate levels, with a peak of 332 pfu at 11/2000UTC. The associated 24-hour fluence remained below the Active threshold, with 2.53e6 integrated pfu observed at 12/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: High to moderate activity expected with M-class flares expected and a slight chance of further X-class flares.

Solar Wind / Geomagnetic Activity: Current CME influence is expected to ease later day 1 and into day 2 (12-13 Sep), before a further arrival is anticipated. This is from the M1.0 flare CME from AR3814 on the north disc at 10/2350 UTC. This is forecast to arrive either very late

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on day 2 or early on day 3 (13-14 Sep). Coronal hole fast winds could potentially arrive day 4 (15 Sep) from CH68/- in the north disc. Geomagnetic activity is expected to be Active to G2 Moderate Storm at first day 1 (12 Sep), with a chance of an isolated G3 Strong Storm, before easing to Quiet to Active with a chance of G1 Minor Storms day 2 (13 Sep). A further enhancement likely follows to Active to G2 Moderate Storms day 3 (14 Sep). Quiet to Active conditions returning later day 3-4 (14-15 Sep).

Energetic Particles / Solar Radiation: High energy proton flux is expected to remain near background with a slight chance of rising given any notable flares, mainly from the regions on the southwest disc. High energy electron flux is expected to remain mainly at Background with the associated 24 hour fluence remaining below Active.

Figure 1a: Current Solar winds showing multiple CME arrivals.

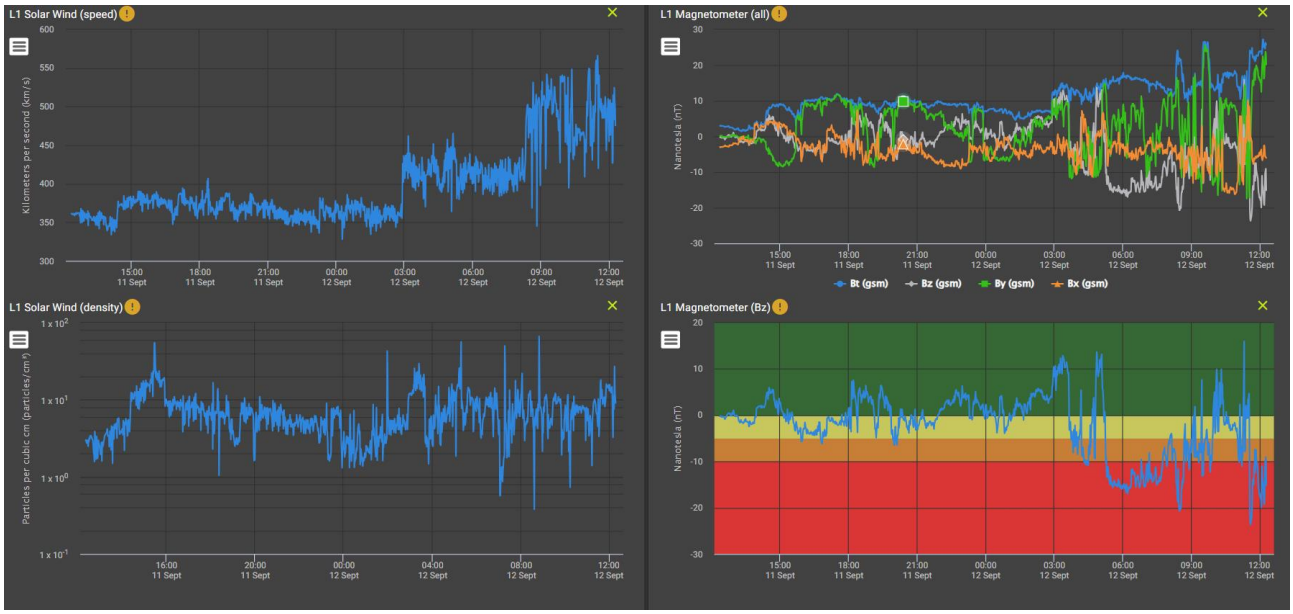

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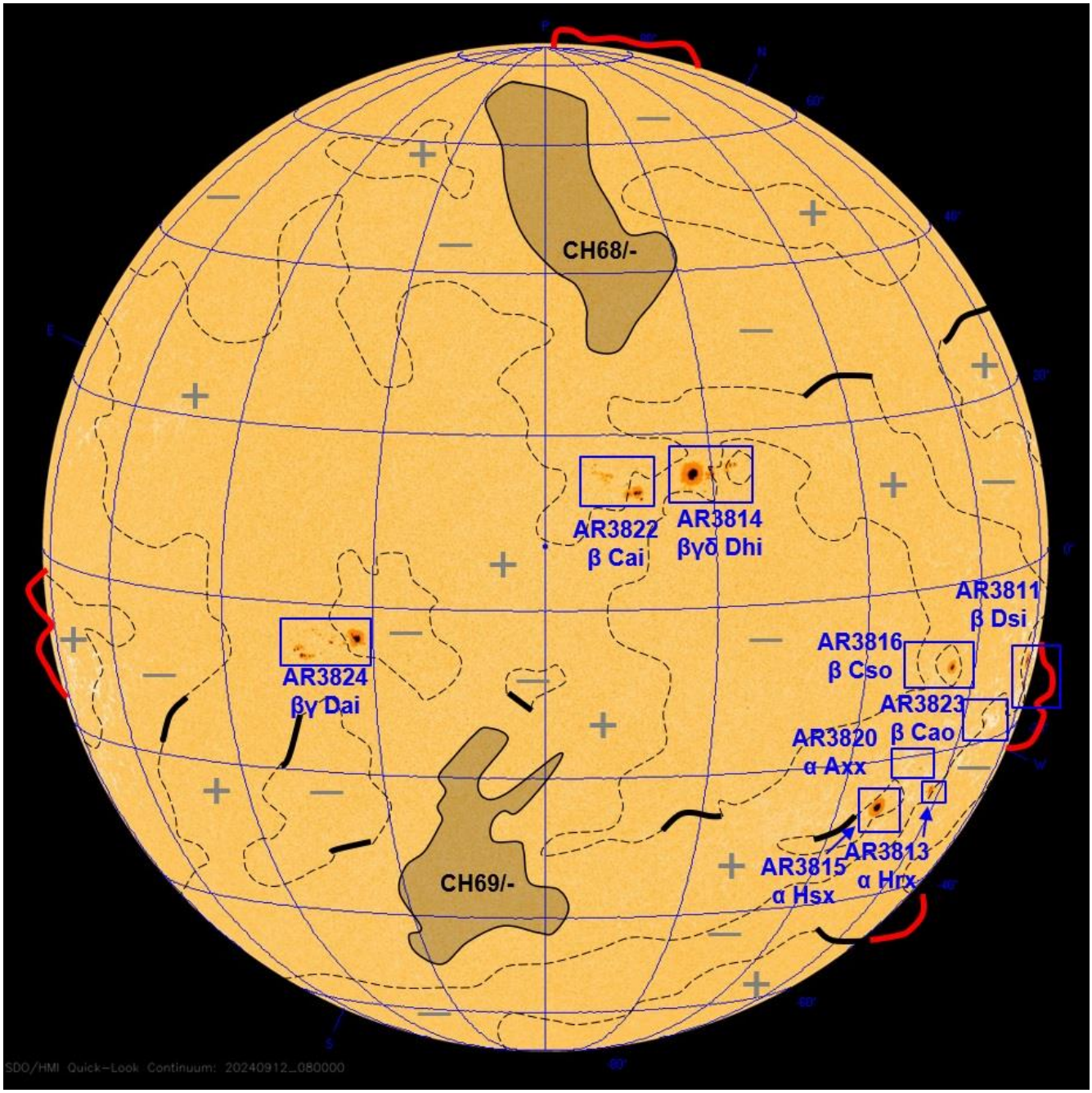
Figure 1b. Solar Analysis Valid 12/0800 UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Earth remains within the CME influence from the arrival at 12/0253 UTC. This has been attributed to an early arrival of the 10/0029 UTC CME, although due to how early this arrived compared to the forecast this is only Moderate confidence. However there are no other clear candidate CMEs for this arrival.

There is a further Earth-directed CME which was observed leaving the Sun around 10/2350 UTC, due to an M1.0 flare from AR3814. This is a relatively diffuse CME, and has lower confidence due to limited available LASCO imagery, but based on STEREO A cor2 imagery is currently forecast to arrive either very late on day 2 (13 Sep) or early day 3 (14 Sep).

Any CME influence is likely to ease later day 3 (14 Sep), however the northern coronal hole feature is also likely to connect later in the period, most likely day 4 (15 Sep), although this is also low confidence, due to only a limited response on MOSWOC Enlil and the northern latitude of the feature.

Geomagnetic activity is expected to be Active to G2 Moderate Storm at first day 1 (12 Sep), with a chance of an isolated G3 Strong Storm, before easing to Quiet to Active with a chance of G1 Minor Storms day 2 (13 Sep), before a further enhancement to Active to G2 Moderate Storms from the next CME arrival day 3 (14 Sep). Quiet to Active conditions returning later day 3-4 (14-15 Sep).

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	80	30	60	5
Strong	G3	No	30	5	10	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
11/0657	Partial	AR3814 M1.0 flare	1E 30N	709 km/s	Late 13th/early 14th	Moderate confidence as diffuse CME and limited imagery

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Radio Blackouts - X-Ray Flares:

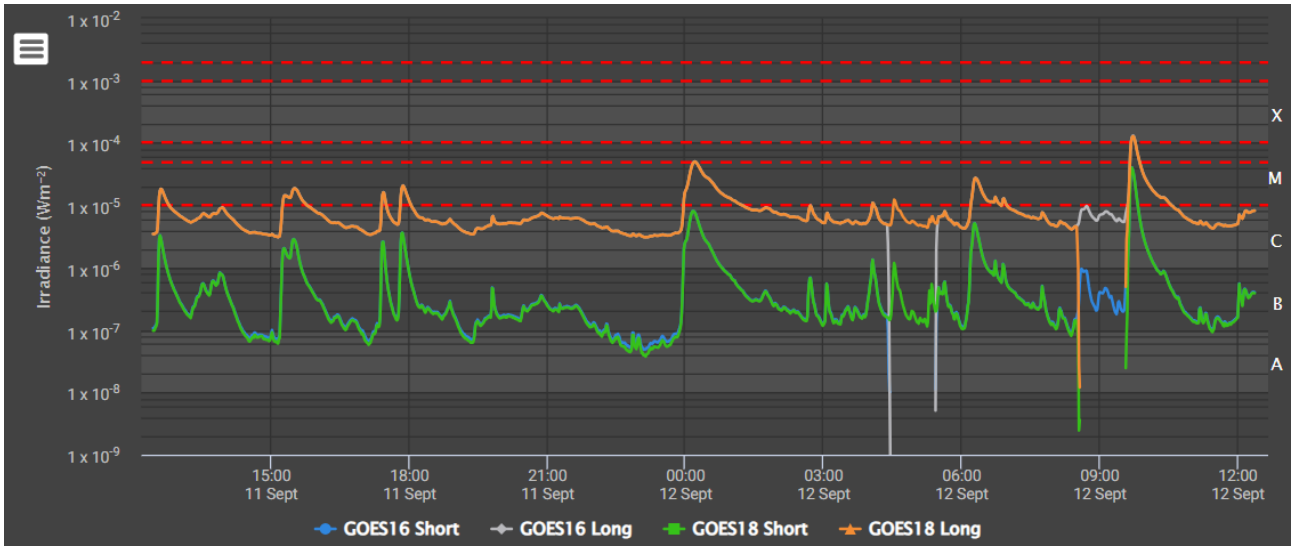
Moderate to High activity is expected to continue.

There are ten regions on the Earth-facing disc, including the new, yet to be analysed region on the southeast limb that was the source of the recent X-class flare. However, with notable magnetic looping evident on the limb on SDO imagery, this brings an ongoing chance of further notable flares.

There are other significant flare source regions on the disc, including AR3811 on the west limb, which is soon to rotate over the limb but also has a notable region of magnetic looping evident above it in SDO imagery. This is the most significant of the cluster of sunspot regions in the southwest, with the others small and simpler. AR3814, just west of centre disc also has the potential for notable flares, with a small delta spot developing ahead of the main spot of the group and has a history of producing M-class flares and associated CMEs. The other regions currently have a lower flare risk as they remain relatively simple.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	75	75	70	70
Very Active	R3 to R5 X Class	Yes	20	20	15	15

Figure 3: GOES-16/18 X-ray flux



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Solar Radiation Storms - (High Energy Protons):

High energy proton flux is now near background, having shown a steady decline after recent enhancements. There remains a slight chance of any further enhancements exceeding the S1 Minor Radiation Storm level, mainly due to the number of sunspots on the southwest disc, but most notably AR3811 on the limb. While this region is expected to move onto the far-side, any decreasing risk from this region will be compensated by AR3814 moving into a better connected location for Earth-directed proton enhancements.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	10	15	15	15
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux is currently at background. Recent CME arrival will have suppress the observed counts at GEO, although some charging is likely at lower orbits. With a further CME arrival anticipated later day 2 or early day 3 (13-14 Sep), and the potential for onset of coronal hole fast winds day 4 (15 Sep), any periods of Moderate flux at GEO are expected to be brief, with mainly Background flux persisting.

The associated 24-hour fluence is expected to remain below the Active level, with MOSWOC REFM currently a good guide to expected levels.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	1	1
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

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